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Relationship of the Frequency of Isolation of Salmonellae to Their Resistance to Drying and Freezing

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The resistance of different *Salmonella* serotypes to drying and freezing has been shown to be related to their incidence in salmonellosis.

Studies of the frequency of isolation of different *Salmonella* serotypes from foods and feeds consistently show that a few strains predominate. This pattern suggests that differences in resistance or pathogenicity, or both, are involved, yet most survival studies are carried out with high-incidence serotypes (1, 3, 4). This study was undertaken to determine the survival of several salmonellae in frozen meats and in a dried meat slurry (similar to that found on equipment in an unsanitary meat handling operation) and to determine if these survival times were related to reported incidence of isolation.

Twenty-seven strains of salmonellae were selected on the basis of frequency of their isolation from both human and nonhuman sources as reported to the National Communicable Disease Center (5). These strains are listed in Table 1.

For the studies on survival in frozen meat, fresh pork was inoculated as previously reported (1) to give a final concentration of approximately 100 cells/g. The meat was stored at −18 C, and the most probable number (MPN) was determined at selected intervals.

To determine the survival on a dry surface, ground pork (aseptically removed from fresh hams but not sterile) was diluted 1:10 with sterile distilled water, inoculated with the test culture, and blended for 1 min. One-tenth milliliter of this slurry was spread over a sterile 1-inch (2.54-cm) stainless-steel square and dried under a laminar flow hood. Final concentration of cells was between 50 to 100 per square. The squares were stored at 10 C and 50% relative humidity and sampled at selected intervals for the presence or absence of salmonellae.

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The *Bacteriological Analytical Manual* (BAM) procedure of the Food and Drug Administration was used to check for salmonellae (2). To determine numbers of surviving salmonellae, the three-tube, three-dilution MPN method was used in conjunction with the BAM procedure.

Table 1 shows a tendency for the low-incidence strains to be more susceptible to frozen storage, but none of the samples was sterile after 10 weeks. The last three columns of this table show an obvious increased susceptibility to drying of low-incidence strains. The low resistance to drying of *S. senftenberg* 775W, which is known for its high resistance to moist heat, is consistent with its low resistance to heat in dry chocolate (3).

Thus, the ability of certain serotypes to survive in a dry, cool environment is probably a factor in their higher incidence of involvement in salmonellosis. The longer survival time for all groups in frozen storage is not surprising since this is a common method of culture preservation. The relationship between relative frequency of isolation and ability to survive environmental stress was not complete, however, and other factors, such as relative virulence, must be involved.

LITERATURE CITED

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TABLE 1. *Relationship of incidence to survival of 27 strains of salmonellae*

Organism	Reported incidence[a] (%)	Reduction in MPN[b] in frozen meat at 10 wk		Survival on stainless-steel squares		
		<90%	≥90%	2 days or less	3–14 days	>2 wk
S. typhimurium	28	2[c]				2
S. heidelberg	8	2				2
S. enteritidis	6	1		2		
S. newport	6	1				2
S. infantis	6	1	1	2		
S. derby	4	1				2
S. saintpaul	4	1				2
S. thompson	3	1			2	
S. blockley	2	1				2
Summary (% of trials)		92	8	22	11	67
S. anatum	1	1			1	1
S. panama	1	1	1	1		1
S. chester	0.5	1				2
S. braenderup	0.4	1		2		
S. litchfield	0.4		1	2		
S. miami	0.4	1		2		
S. indiana	0.2	1				2
S. senftenberg	0.2	1		2		
Summary (% of trials)		80	20	57	6	37
S. choleraesuis var. *kunzendorf*	0.1			2		
S. muenster	0.1	1	1	1	1	
S. rubislaw	0.08	1				2
S. choleraesuis	0.06		1	2		
S. paratyphi A	0.04	1		2		
S. paratyphi A var. *durazzo*	0.03	1	1	1	1	
S. havana	0.03	1	1	1		1
S. gaminara	0.02	1		2		
S. pullorum	0.01	1		2		
S. senftenberg 775W	0.00	1		2		
Summary (% of trials)		67	33	75	10	15

[a] Average of reported incidence of isolation from human and nonhuman sources as reported by Center for Disease Control in 1963–1969 Surveillance Reports.

[b] MPN, most probable number.

[c] Number of trials.